THE GAS COALS OF OHIO.

By Emerson McMillin.

To determine the commercial value of any particular coal for gas-making, several points must be considered. First, convenience to market; second, quantity and illuminating power of gas to be obtained from the coal; third, character and weight of coke; fourth, freedom from impurities.

The first point—convenience to market—is one of great importance. Mines located along navigable streams and water-ways for transportation, have greatly the advantage of coal that must be transported by rail, Youghiogheny coal being carried down the Ohio river, a distance of 500 miles, to the largest market of the State, at a less cost than coal can be transported by rail from the great coal fields of Hocking and Perry counties, distant only 120 to 200 miles from the same market.

So far but little effort seems to have been made to introduce the coals from mines located along the Ohio river, in this State, into gas works.

The great Pittsburgh seam is accessible to the river at several points, and notably so at Pomeroy. The coal from the numerous mines at Pomeroy has been in the market for many years as a favorite domestic and steam coal, and recently it has been tried at some gas-works in this State and in some Eastern cities with fair results. The coal tested, however, was rather better than the coal known in the market as Pomeroy or Ohio river coal, it being from a mine recently opened, but still in the Pittsburgh seam. Could the rich cannel coal of numbers 3, 3*a* and 3*b* seams, mined in Vinton, Jackson, Licking and other counties of the State, be put into gas-works at same cost as Youghiogheny coal, the former would be very largely used, and possibly to the exclusion of the latter, where gas of high illuminating power is sought for.

This brings us to the second point of consideration—quantity and illuminating power of gas to be obtained from a given quantity of coal.

Coal yielding 4 feet to the pound is not worth four-fifths the value of coal that yields 5 feet to the pound. The use of the richer coal reduces the cost of necessary plant, labor in retort house, wear and tear of retorts, and the consumption of coke for fuel. The illuminating power being the same, and the value of the richer coal being placed at $2.50 per net ton at gas-works, then the value of the leaner coal will not exceed $1.95, and probably not $1.90, especially to small works, not using or disposing of their ammoniacal liquor. But, as a rule, the richer coal gives gas of a higher illuminating power than does the leaner article. Coal giving a high candle power gas, often possesses great value, even when giving an inferior coke, and not extraordinary yield in quantity, in this, that it may enable the gas-works to use a poor coal, or a coal that makes a low candle power gas, but which from its nearness or convenience to the works, can be obtained, relatively, much cheaper than good gas coal.

General figures and calculations cannot be given that will be of much value or interest to works in any particular locality, but with the number of gas works located in the coal producing territory of the State, it seems that by a proper admixture of the local coals that can be obtained cheaply with the cannel of numbers 3, 3*a* and 3*b* (the Mercer and Tionesta coals), a much greater quantity of Ohio coals might be used with profit to the gas companies.

In many localities local coals, say of numbers 5 or 6 (the Kittanning seams), may be obtained at $1.50 per ton, and cannel at $3.00 per ton. Number 5 will produce 9,000 feet to the net ton of 13-candle gas. Number 3 cannel, 9,000 feet of 24-candle gas, the mixture giving a coal at $2.25 per ton that yields 9,000 feet of 18.5-candle gas, with good coke from half the coal, and inferior coke from the other half or from the cannel coal.

Weight and character of coke ranks third in determining the value of gas coals. In both quantity of coke produced from a ton of coal, and in the quality of such coke, Ohio coals are generally inferior to Youghiogheny coal. The Pittsburgh seam in Ohio gives a coke inferior only perhaps in quantity of sulphur it contains, and possibly a slight excess of ash.

The number 5 seam, of southern Ohio, gives a coke very similar in appearance to Youghiogheny, but carries so much sulphur as to be useless for many purposes for which good coke is used. Number 6 seam gives a lighter and more pulverulent coke, containing more sulphur than the Youghiogheny gas coke. Its structure is such as to cause it to be consumed with greater rapidity, producing intense heat and fluxing the ash to a greater degree than is the case with Youghiogheny gas coke.

The fourth and last general point to be considered in determining the value of any particular coal for gas making, is its impurities. The term impurity is here used in the sense that is usually applied in the gas works of the United States, and particularly in the smaller works, referring to the sulphur compounds, sulphuretted hydrogen and bisulphide of carbon.

An analysis for total quantity will not always determine the question whether a coal contains a too large per cent. of sulphur to be profitably used in gas making. Two coals containing equal per centages of sulphur may produce gas—the one easily purified, and the other foul and hard to purify. But the question of purification is one of much less importance now in determining the value of coals than was the case a few years ago.

The general adaptation of oxide of iron, in its various forms, has so reduced the cost, that the expense of removing the sulphuretted hydrogen has become almost nominal.

But lime is still used for the removal of bisulphide of carbon and carbonic acid.

Ammonia, in its various forms, has not here been treated or considered as an impurity, as the cost of removal in small works is insignificant, while in the large works the ammoniacal liquor is often a source of revenue.

Both carbonic acid and carbonic oxide are impurities and are produced to a greater extent by the use of some coals than by others. Yet we have not considered either of these impurities in making suggestions for the determination of the value of gas coals, as the manner of manipulation often has as much to do with, and is as much at fault in the production of these impurities, as is the character of the coal.

Coal having no definite composition, and coals of almost identical composition as ascertained by ultimate analysis giving totally different results when distilled in a gas retort, renders it impossible to lay down any positive rule for judging a good gas coal by its analysis. But it is safe perhaps to say that the gasmaker should choose the coal that contains the largest per cent. of hydrogen, and the smallest per cent. of oxygen. While it is well known that the combustion of hydrogen at the ordinary pressure of gas consumption, results simply in producing a blue flame without light, and it is equally certain that the light of the gas flame is produced by the incandescence of the carbon of the gas; still, as before stated, the best gas coals are those which contain the largest per cent. of hydrogen, and consequently smallest per cent. of carbon, and the less oxygen the better.

The larger the per cent. of hydrogen that coal contains, the greater the quantity of carbon that can be volatilized, and the combustion of the hydrogen at the tip of the gas burner is necessary to produce the proper degree of temperature in the carbon to give us the incandescent light, and to eventually promote the ignition of carbon, and its conversion to carbonic acid, and thereby preventing the escape of free carbon and the creation of smoke and deposition of soot.

The analysis of the best gas coals often shows the per cent. of ash so great as to be almost beyond belief. The coke from Boghead cannel, a coal that yields 13,000 to 15,000 feet of thirty-five to forty candle power gas, has analyzed 70 per cent of the weight of the coke in ash. Other good coals of the cannel character range down to 20 per cent. of the weight of its coke in ash. Coals used in gas works of this and other countries vary in quality from one grade yielding 6,000 feet to the net ton of thirteen candle gas, up to 12,500 feet of 131 candle gas; the latter coal, if coal we are permitted to call it, being known as the Hartley mineral of New South Wales—the one yielding thirty-nine candle feet to the pound, the other yielding eight hundred and twenty-nine candle feet to the pound.

The Albertite of Nova Scotia will yield 13,300 feet to the net ton of nearly fifty candle gas, or three hundred and thirty candle feet to the pound. Grahamite, of West Virginia, 13,500 feet of twenty-eight candle gas, or one hundred and eighty-nine candle feet.

But few persons can realize the magnitude of the gas industry of this country. There are now in the United States more than seven hundred incorporated gas companies, doing business with a capital of over two hundred million dollars, and employing more than twenty-five thousand men. Just what amount of capital is employed in this State in the manufacture of and distribution of illuminating gas, could not be ascertained by the writer, but as more than ten per cent. of the total gas works of the country are located in Ohio, it is probably not too high an estimate to place the capital at 7½ per cent. of the total, or about fifteen million dollars, and this business has grown up almost entirely during the last generation. The first gas works of the State were built in Cincinnati, in the year 1842; the town being first lighted January 14, 1843; the second at Cleveland during the year 1849, and the third at Zanesville, same year. There are seventy-five gas works now in operation in the State. Ten years ago, prices for gas ranged from $2.50 to $5.00 per thousand feet. Prices now range from $1.25 to $3.00. With the rapid growth of towns and cities, and consequent increased demand for gas, the companies have been enabled to correspondingly reduce the price. While the growth of the business has been rapid, we are led to believe that the business will make much more rapid strides during the next than during the last decade; and this, notwithstanding the introduction of lighting by electricity. In fact, so far the new light has rather helped than hurt the gas interest. It has apparently spurred the companies to seek new fields, to introduce improved apparatus, to lower the price of gas and thereby stimulate its use for motive power and for cooking and heating stoves, and in many ways the business has been increased to a degree that far more than compensates for the loss of the few consumers that have substituted the electric light for coal gas.

One of the best authorities of the State gives it as his opinion that a capital of $8.00 per one thousand feet, or a capital equal to $8.00 for every one thousand feet of annual production, is about what is required in this country to construct and successfully operate a plant for the manufacture and distribution of gas. This is too large for large cities and too low for small towns, but the average is not far from right, and, figuring upon this basis, the capital employed in this State should be about what is given at top of this page, viz: fifteen million dollars.

In reply to inquiries made of all the gas works in the State, only about 18,000 tons of Ohio coal is reported as being used in the gas works of the State during the year 1882.

While many works failed to respond to the inquiries, it is believed about all did so that are using native coal. It would be quite within bounds to say that not to exceed 25,000 tons per annum of Ohio coals are used in the great industry of making illuminating gas. This is less than 10 per cent. of the total quantity used.

This may be accounted for—first, from the fact that the Ohio coals are generally dryer burning, and contain less bitumen, making a lighter and more pulverulent coke, and containing less volatile combustible matter; second, from the fact that Cincinnati, a city making about one-third of all the illuminating gas that is consumed in the State, can be supplied with the fine gas coals of the Youghiogheny region, at less cost per ton (river transportation) than the leaner Ohio coals can be delivered for. Again, Cleveland, the next largest city in population, and second only to Cincinnati in gas consumption, and making about one-fifth of the total production of the State, can be reached with Pennsylvania coal of superior quality with less cost than coal can be delivered from the principal coal fields of Ohio. Columbus, making about one-tenth of the total production, has for a number of years used coal from the Hocking coal fields, almost exclusively—the inducement being a short haul from the Hocking Valley, while a long haul by rail is required to deliver the Youghiogheny coal to the Capital city.

Coal is used for gas making from several seams of the Ohio series, yet the Middle Kittanning seam, No. 6, probably furnishes three-fourths of all that is used in gas works.

The reports from a number of gas companies show that an average of not to exceed 3.75 feet of gas to the pound is obtained from this coal, though some works do much better. The coke seems to be a favorable one for base-burning stoves, and some classes of smithing, but for the cupola and blast furnace purposes it is quite inferior to the oven coke of the Connellsville region, or to the gas coke made from Pittsburgh or Youghiogheny coal. A cannel coal obtained in several localities from the number 3, 3*a* and 3*b* seams has been used to a limited extent, and may yet be developed into one of the principal gas making coals of the State.

The seams are generally thin, and have not been much developed along lines of railroads, or if on railroads, then quite distant from the larger cities. The Lower Kittanning coal, No. 5, has been used at several of the smaller towns for many years. This coal is reported to yield $4\frac{50}{100}$ feet of gas to the pound of coal, and the coke from it is superior to that made from the number 6 seam (except that it contains more sulphur), or from either of the other seams, excepting only number 8, or the Pittsburgh seam.

It is doubtful if any coal in Ohio is entitled to the distinction of being classed as strictly a gas coal. There are probably twenty-five, and not to exceed thirty gas works in the State that use Ohio coal exclusively, and a few others that use it in part as a mixture with Youghiogheny coal. Generally these works are small.

Sufficient importance does not seem to be attached to the difference in coals for producing gas. For instance, one coal will produce 4 feet of 14.5 candle gas, another 4.40 feet of 16 candle gas. Now, if the two coals produce about the same weight and character of coke, it is quite a common error to rate the second coal as about 10 per cent. better than the first. As the object to be obtained in the decomposition of coal is light, a simple calculation will show the fallacy of such rating:

$$4.40 \times 16 = 70.40 \text{ candle feet.}$$
$$4.00 \times 14.5 = 58.00 \text{ candle feet.}$$

Difference, 12.40 candle feet.
Or, 17.61 per cent.

In most mines of this State driven in on coal No. 6, or the great vein, there are found three members of the seam, the lower member being the softest and apparently the best part of the vein. The second member is much the thickest and usually of good quality. The third or upper member is sometimes missing, and often of poor quality, containing a large per cent of ash. In the Hocking Valley district this member is often left to form the roof of the mine.

Sometimes this member is found to be a fair cannel coal, very rich in light-producing gas; the yield of gas is quite good, and the quality of the gas most excellent, being of a higher illuminating power than was obtained from a test of the justly celebrated cannel coal of the Kanawha Valley. Whether there is sufficient quantity of this coal that partakes of the cannel characteristics to make it of economic value, the writer is not prepared to say. The question is one, however, worthy of thorough investigation.

The coke made from this coal or cannel is very inferior, containing a large per cent. of ash.

The presence or absence of this cannel in coal purchased by gas works will in a measure account for the very different results obtained by the different works of the State that have used Hocking coal.

With a proper admixture of the lower members of the seam with the cannel, very fair results may be obtained.

Assuming that a mixture of the two lower members of the seam will produce four feet to the pound, or 8,000 feet to the net ton of 14 candle gas, and that the cannel will produce four and a half feet or 9,000 feet to the ton of 19 candle gas, then a mixture of three-fourths cannel and one-fourth coal will produce,

$$1 \times 8 = 8 \text{ and } 8 \times 14 = 112$$
$$3 \times 9 = 27 \text{ and } 27 \times 19 = 513$$
$$4)35 \qquad)625(17.86$$

8,750 feet of 17.86 candle gas.

Half cannel and half coal will produce,

$$8 \times 14 = 112$$
$$9 \times 19 = 171$$
$$2)17 \qquad 2)283(16.65$$

8,500 feet of 16.65 candle gas.

One-fourth cannel and three-fourths coal will produce,

$$1 \times 9 = 9 \text{ and } 9 \times 19 = 171$$
$$3 \times 8 = 24 \text{ and } 24 \times 14 = 336$$
$$4)33 \qquad)507(15.36$$

8,250 feet of 15.36 candle gas.

By the analyses made by Prof. Wormley, as published in the first volume of the Ohio Geological Survey, it is clearly shown that but a small per cent. of the sulphur in some of the coals analyzed was in combination with iron. What the combination really is, I believe is unknown.

As before stated, analyses show that in some coal nearly all of the sulphur passes of in the gas, while with others a very large per cent. remains in the coke. It is quite probable that the conditions of the analysis have much to do with bringing about these results, and that two analyses of the same coal may, in one instance, give coke nearly free from sulphur, and the other show most of the sulphur remaining in the coke. In the volume just referred to it is stated by analysis, or rather by carbonization, Pittsburgh coal is shown to yield 3.50 feet of 14 candle gas per pound of coal, and the Hocking coal is shown to yield 3.30 feet of 18 candle gas.

The fact is, that good Youghiogheny or Pittsburgh coal yields, in all large well managed works, 4.75 feet to 5.25 feet of 15 to 17.5 candle gas to the pound of coal, while by actual tests the Hocking coal yields, leaving out the cannel of No. 6, 3.74 to 4.20 feet of 13 to 15 candle gas per pound of coal carbonized.